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Featuring

Engineering and the Industries of Japan

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JOURNAL OF THE

BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XVII JUNE, 1930 Number 6

# ENGINEERING AND THE INDUSTRIES OF JAPAN

By Charles T. Main,* Past President, Boston Society of Civil Engineers

(Presented at a meeting of the Society on May 21, 1930)

On invitation of the Japanese government, and acceptance by the engineers of several nations, it was arranged to hold the World Engineering Congress in Tokyo, Japan, from October 29 to November 7, 1929.

With the approval of the International Executive Council, it was decided to hold a sectional meeting of the World Power Conference in Tokyo simultaneously with the Engineering Congress.

The World Engineering Congress was held under the auspices of the Kogakkai, the Engineering Society of Japan, which is a federation of twelve major engineering societies of Japan.

There were about 130 delegates from our country to the Engineering Congress, and, adding their guests, there was a total of about 250 Americans attending. Delegates and guests from other countries made a total of about 500. There were said to be about 2,300 Japanese delegates.

The majority of the American delegates, together with their guests, sailed from San Francisco on the official boat, the "President Jackson" of the Dollar Line, on October 10, 1929. Other delegates sailed on the "Korea-Mara," the Japanese boat, on the same day, and some went east instead of west.

We arrived at Honolulu on the 16th and sailed on the 17th. During the stay in Honolulu the party was royally entertained by the Engineering Association of Hawaii, with excursions and a great dinner with Hawaiian music and dancing.

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Then we sailed on over the vast Pacific Ocean, the size of which nobody appreciates until he has sailed it, landing in Yokohama on the morning of the 27th. We were met by members of the Japanese delegation, who helped us with our luggage through the customs, which was a perfunctory motion, and assisted us to reach our respective hotels.

Mt. Fugi was visible in its full glory the morning we landed. That was the only sight we had of that majestic mountain, except two fleeting glimpses of its top on other occasions.

Early estimates had placed the number of our combined parties at about 350. We descended upon Japan with about 500, thus producing an overload of more than 50 per cent, and making it necessary for some of us to be quartered, at least temporarily, in Yokohama, about 20 miles from Tokyo, where all the meetings and other functions during the sessions were to be held. Most of these unfortunate ones were moved over to Tokyo during the week.

The object of the Congress, as stated by the Japanese, was "to effect an international exchange of the latest knowledge of science and practice of engineering, and to bring together the leaders in research, education and business who are directing the trend of engineering activities, thereby initiating and promoting international co-operation and understanding between the engineers of the world, so essential to the advancement of the welfare of mankind."

I strongly suspect that the officials and leading men in Japan were desirous of having engineers from the various countries visit their country to get first-hand information, and to get personal impressions of the country and its industries. They could advertise their country in no better way.

### Sessions

The opening session of the World Engineering Congress was held in the forenoon of October 29, in the Municipal Auditorium, with addresses by Prince Chichibu, Hamaguchi, Prime Minister of Japan, Baron Koi Furuichi, President of the Congress, and responses by the chairmen of the overseas delegations.

The opening of the World Power Conference was held in the afternoon in the Parliament House.

Then we were off with continuous sessions until November 2. An interval followed, from November 2 to 5, for excursions, and then again sessions from November 5 to 7.

The Congress was divided into twelve sections, and the Conference into four sections, in which meetings were held simultaneously and at which 794 papers were presented in the Congress and 135 in the Conference.

Japanese and English were the two languages in which papers could be presented, and it was stated that all but two papers were presented in English.

Interspersed with the sessions were receptions, teas, luncheons, garden parties and dinners, theatres, and the excursions, November 2 to 5.

It was impossible for one to attend more than a fraction of the sessions and functions, and my impression is that but few of the visiting delegates attended the technical sessions with any regularity.

Fig. 1. — Rice Cutting

## Excursions

On October 8 there began a series of excursions to the principal places of interest in Japan, which kept the delegates busy days and some nights, continuing to the time when it was necessary to return home.

On all of these excursions the delegates were royally entertained by local committees, municipal officials, chambers of commerce, etc., with dinners, lunches, garden parties and speeches, and they were showered with gifts.

One member, in reviewing the work of the Congress, said that he had decided that W. E. C. meant "we eat constantly."

Free railway tickets on all government lines were issued to a member and one other of his family.

Too much cannot be said in praise and appreciation of the great courtesy and generosity with which we were treated. The attentions bestowed on us were lavish, and no country in which there may be held in the future another Congress can expect to exceed it, and should be excused if it does not try to equal it.

I cannot refrain from mentioning the personal attention conferred upon some of us.

Baron Takuma Dan was at Technology in the class of '78. He was one of Professor "Bobbie" Richards' boys, and Bobbie was the guest of the Baron, living at his house and having two men to look after his personal welfare throughout his visit.

Henry Hibbard was in the class of '77, in the department of mining engineering, also. I was in '76. Mr. and Mrs. Hibbard and my party were assigned to the New Grand Hotel in Yokohama. Baron Dan, realizing the inconvenience we would be put to, and wanting to do something more for Technology men, arranged to have us moved over to Tokyo and occupy the guest house of the Mitsui Company, which is a beautiful building with a charming garden of a few acres. There were several servants with perfect service and two automobiles at our disposal.

One evening young Mr. Mitsui, who is a Dartmouth graduate, gave a delightful dinner to the M. I. T. men and their wives and daughters, at which there were about a hundred present. Dr. Dan presided.

## Shopping

The ladies had a glorious time shopping, and in many cases buying, in the various places we visited. The wonderful products in silk, cloisonné, lacquer, porcelain, jewelry, etc., were extremely interesting and enticing.

## Results of the Congress

The Japanese seemed to be very keen for the technical sessions, and in all probability the results were beneficial to them, but there were so many sections in which meetings were held simultaneously, and so many social events, that there were but few of the foreigners who religiously attended the sessions.

Probably the greatest benefit of the Congress did not come from the technical meetings and papers, but from the intermingling of the delegates from the various countries, thus creating a better international feeling of lasting benefit, and the acquisition of a better knowledge and understanding by us of the Japanese people and nation.

## OBSERVATIONS

Our stay in Japan was so short, and the ground covered so extensive, that it was impossible for us to be very thorough in our examination of the various phases of the country, the life, and the industries.

We are, therefore, obliged to get much of our knowledge from discussions among ourselves and from books, papers and pamphlets. In the preparation of this paper, I have made free use of the valuable and interesting book entitled "Industrial Japan," which was prepared by twenty-six specialists and printed for the delegates to the Congress.

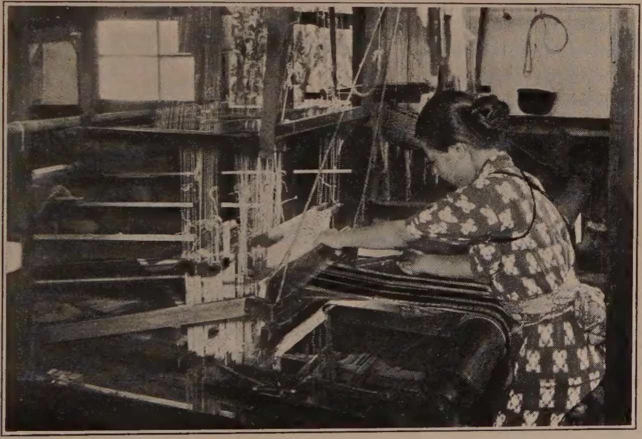

FIG. 2. — SILK WEAVING

## JAPANESE EMPIRE

The Japanese Empire consists of five large islands and about 430 small islands, and the territories of Japanese Saghalien, Korea and Formosa.

The Island Empire has an area of 260,038 square miles, of which Japan proper occupies 147,292 square miles, and a population of 84,565,000 (1925 census), ranking her as the fourth most densely populated country in the world.

It extends from latitude 21° 45′ to 50° 55′, which in this hemisphere would be from the middle of Cuba to a little north of the St. Lawrence River, and, therefore, has great variety of climate and attractions.

The people seem to be divided into two classes, — the patrician type, symmetrically and delicately built, of complexion varying from yellow to almost white, and the plebeian type, of heavy-boned, robust physique with dark skin. Between the highest and the lowest there seems to be a vast gulf, and yet they all seem to mingle as naturally as members of a great family. They are an intensely human lot, earnest, industrious, and clever in their work; many of them are proud, but all are courteous, friendly and cheerful; but history indicates that they are not always a happy people. We might well take some lessons from them in manners, orderliness and cleanliness.

## History

The early history of Japan is more or less legendary, as writing was unknown until the sixth century, when the Chinese characters were introduced. The government was remodeled on the Chinese centralized, bureaucratic plan, and after that the country passed gradually from a relatively crude condition to a state of civilization. Since then the history of Japan may be divided roughly into three periods:

The Nara Period (710–784) when the Imperial Court built a town called Nara, and established itself there. This period was distinguished by extraordinary zeal in Buddhism, and seven of the finest temples were erected, some of which are still remaining.

Then followed the Kyoto Period, from the end of the eighth to the middle of the twelfth century, with the central government located at Kyoto. The character of the people changed from rude warriors to that of a milder form.

Then followed the Military Period, from the last of the twelfth to the middle of the nineteenth century. This was the age of military feudalism, when the Shogun exercised the administrative functions, leaving to the Imperial Court only ceremonies. A portion of this period was one of great turbulence, but when Tokugawa assumed control there began a period of 250 years of internal peace and development. This period ended at the time of the Restoration in 1868.

On October 14, 1867, the Tokugawa Shogunate fell. It consented to be stripped of its legislative authority in favor of the Emperor. This date marked the overthrow of the dual system of government, the practical extinction of feudalism, and the emerging of Japan on the road which since has led her to one of the highest places of the progressive nations of the world.

Under the present government the executive power is vested in the Emperor, and is exercised through thirteen ministers, whom he appoints and who are responsible to him. There is also a Privy Council of statesmen of wisdom and experience who are consulted by the Emperor. These serve at his pleasure.

The Diet is composed of two houses, a House of Peers of about 400, partly elected, and a House of Representatives, with 466 members, elected by the people.

The Empire proper is divided into three metropolitan districts and 43 prefectures with their governments, and the cities, towns and villages have their self-governing bodies.

## INDUSTRY

There is little of interest relating to industry before the period from the sixth to the eighth century, when the Chinese and Korean influence came with Buddhism. It was from that country that the Japanese learned sericulture, the art of silk weaving, making pottery, sculpture, architecture, etc. They also learned from China, to which missions were sent to study Chinese culture and various branches of industry. It is said that up to the sixteenth century the cultured element of Japan was developed solely with the influence of the Asiatic continent. Thus, Japan remained Oriental for a long time.

FIG. 3. — SHOE SHOP

The direct influence of western civilization was brought to bear when a Portuguese ship, in 1541, and a Spanish ship, in 1548, visited the country. They were followed by Dutch, and the intercourse with ships became frequent.

In 1853, Commodore Perry came to Japan and delivered a letter of President Fillmore asking for friendship, commerce, a supply of coal, and protection for shipwrecked people, and returned for an answer early the next year. A treaty was signed in 1854, in which Japan consented to open two ports to American trade.

In 1858, a new treaty was made with the United States. On the basis of these treaties, Japan concluded treaties with Great Britain, Russia, the Netherlands and France, and, at a later date, with other European powers.

Having once given up her policy of seclusion, Japan exerted herself to the utmost to enter into closer relation with foreign countries.

Shortly prior to the Restoration, some modern industries were started, but it was not until the Restoration in 1868 that there was a real awakening. There was a great rush towards the new western civilization, and the industries which were peculiarly Japanese dwindled. Later there was a sort of renaissance, but, in general, tradition was cast away.

Enough of the traditional industries remain to give interest and pleasure to the visitor. They are generally on a small scale and in many instances still primitive.

For several years after the Restoration, the artists and master craftsmen had a hard struggle to get a mere living, but about 1884 there was a return to a more settled condition, and some branches of the old industries were re-established.

The government sent experts and experienced craftsmen to the United States of America, England, France and other countries, who returned and established model factories for the people to copy.

Students and missions were sent abroad to learn new methods and to import new machines and utensils. They have gathered in the best from all countries, and are changing and adapting them to their own needs and conditions.

Following the war with China, the industries developed rapidly, especially in Osaka, which became the natural economic center. Osaka is now a wonderful manufacturing city with over 2,250,000 population, the fifth largest city in the world, sometimes called the Manchester of Japan.

With her victory over Russia, Japan began to develop strong self-reliance in her international dealings. The consensus of opinion was that she should have her doors open to the markets of the Orient and South Ocean islands. Partly with this in view, and partly because of the location of the largest coal mines, the southwestern provinces were chosen for the new center of industrial development, and spectacular developments centered about the cities located there.

During the World War there was a marked diminution or discontinuance of imports. Japan then was abnormally expanded. The expansion was most marked at Nagoya and vicinity. This was the center of the textile, ceramic and other industries from olden times. It is situated near the Japan Alps, and cheap electric current was available. Many large factories, systematically planned, were established.

FIG. 4. — ENTRANCE TO TEMPLE

## THE GOVERNMENT IN INDUSTRY

As Japan entered so late into international relationship, and being located so far from Europe and America, it was incumbent upon the government to act as a channel for introducing every phase of western civilization, and protection and subsidies were necessary. Many of the undertakings are under the direct supervision of the government. The railroads are either owned or subsidized by the government. Shipbuilding is encouraged by having some material furnished, by exemption from taxes, etc. The Imperial Steel Works were established, and protection given to privately owned work by exemption from taxes and by subsidy. Measures were taken to encourage the chemical industry.

In many ways the people are ruled by, or look to, the government for assistance. There seems to be no doubt that, on the whole, the course taken by the government since the Restoration was necessary, and was a wise one. Whether it has tended to decrease initiative is a question. It would seem as if it inevitably must be so.

## Scanty Natural Resources

Japan is handicapped to a great extent by the dearth of her natural resources. Of those commodities which are indispensable for a nation's sustenance, or serve as industrial raw materials, coal and raw silk are the only things she can supply in sufficient amounts. For all other necessities she has to depend on importation from abroad.

## Labor

Japan is small and the population dense. There is no lack of intelligent and skillful workers. Since they are small of stature, some of the machines from the West have been redesigned to meet the local uses.

With the introduction of western methods came labor and socialistic problems. In 1925 the manhood universal suffrage bill was passed, and since then there have been formed many labor and proletariat parties in co-operation with labor unions.

## Industrial Education

Technical and industrial education is given at universities, high schools of technology, polytechnic schools and industrial continuation schools, all under the government control. There are many good periodicals on engineering, architecture and the industries.

There are scientific and industrial research laboratories which are doing fair work, and some intensive research work is being done by some of the industries.

## Civil Engineering

In 1873, the Home Department was newly established, and the Bureau of Civil Engineering was put under its jurisdiction. The Home Minister was entrusted with full authority in the administration of all civil engineering works, for granting charters to the works promoted either by a public body or private enterprises, and for superintending, protecting and supporting all such works in the country.

## MECHANICAL ENGINEERING

Mechanical engineering in Japan not only includes design, but construction also.

The government expended a large sum toward encouraging and fostering industry and physical improvements. It installed plants, provided them with the best machinery obtainable, and finally turned them over to private companies on easy terms. It also established schools for training young mechanics and manufacturers.

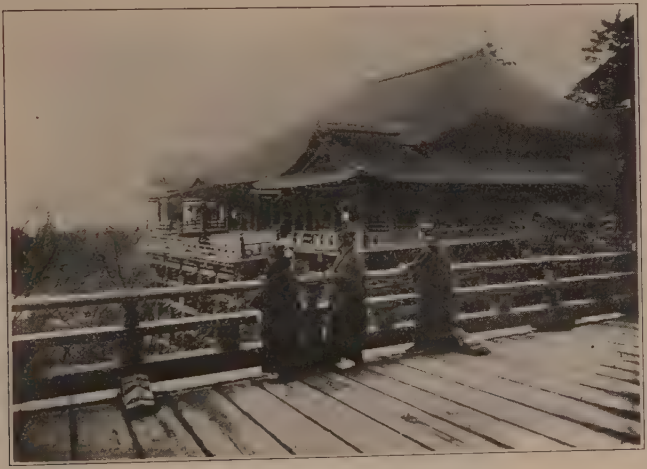

FIG. 5. — TEMPLE

## ARCHITECTURE AND THE BUILDING INDUSTRY

Early architecture of any consequence was largely Chinese, gradually becoming compromised in accordance with the national climate, customs, manners and tastes of the people.

The design and construction of the temples and their surroundings show that the architects of those days had a wonderful conception of design, and that the constructors were men of great skill and ingenuity. The modern architect can profit by a study of these structures.

After the Restoration, European architects were invited to build many of the principal buildings, so that there are French, English, American and German styles.

After the great earthquake of 1901, the Japanese architects began to study how to devise earthquake-resisting structures, and they introduced the style of American steel framed buildings. After the earthquake of 1923, still greater study was given to these problems, and it is probable that Japan now is one of the most advanced countries in theory and practice of earthquake-resisting construction.

The building industry is an important one, especially since the earthquake of 1923. The cities of Tokyo and Yokohama have been transformed. Cities of a new type have been built. Instead of narrow, unpaved alleys, Tokyo has a system of wide boulevards, well paved. Tokyo and Yokohama were formerly connected by narrow alleys, and now a wide motor road joins them.

Some very interesting building work is going on in Tokyo. The architecture is not very different from our own, except for the unusual strength for earthquake resistance.

## Industrial Japan of the Present

Very little is known about any of the industries as carried on in the early history of the country, except that everything was done by manual labor; that some results were crude, and in many cases they were wonderfully beautiful. There are no records back of 600 or 700 A.D. There were no radical changes later until after the Restoration.

Everything which is modern dates no farther back than 1868. Since that date, technical education, engineering and the industries have been closely allied. Largely under the guidance and supervision of the government the industries have been developed and production gradually increased, until now nearly everything required for home consumption is produced, and the exports are of great importance in the national budget.

## Agriculture

It was formerly said that agriculture was the largest industry of Japan. It still is a great industry, in that it is the great and important food producing industry for the country, but with the limited area of arable land it cannot be expected that there can be raised any great amount of product for export. Commerce and the industries must be depended upon for expansion of the national wealth.

Only about 15 per cent of the area of the country is arable land. This portion is intensively cultivated. It seems as if every available square foot is utilized. The land is cut up into small farms, the cultivation being mostly done by manual labor. The fields are beautifully kept.

The principal crops are rice, wheat, barley and mulberry, the leaves from which are used to feed the silkworms. Rice is the principal crop, but not enough can be raised to supply home consumption, of which about 30 per cent is imported.

## SERICULTURE

Sericulture, the raising of silkworms, is one of the most important industries in Japan. Its product accounts for about 40 per cent of the total amount of exports. Japan supplies about 60 per cent of the silk consumption of the rest of the world.

FIG. 6. — PRIVATE RESIDENCE

Silk-producing districts have increased rapidly in recent years. There is scarcely a rural commune without its mulberry plantation. The production of raw silk has accordingly made a great increase.

Artificial silk is also produced to some extent in Japan. Nobody knows what effect its manufacture will have on sericulture.

## SILK

The history of the silk industry goes back about three thousand years.

At the beginning of the era of Emperor Meiji, 1867, the golden age of Japanese silk began.

In 1871 a silk throwing mill was built, from which machines were distributed to other sections. The government also built a typical mill, which a French expert managed, and instructed foremen from every district. As a result, the raw silk reeling work began to be a factory industry apart from the hand work of the house, and at length silk came to occupy the first position in the Japanese export trade, and to have a delicate relation with national economics.

With some slight fluctuations, the amount and value has been on the gradual increase from 1883 to 1927.

The value of raw silk exported in 1927 amounted to about $370,000,000. Of this, the United States of America absorbed nearly 94 per cent.

There has been a period of many years in our country when any semblance of combinations or associations among manufacturers producing similar products was either illegal or frowned upon. In Japan there are associations of manufacturers established for the purpose of regulating production and trade, and the government itself sometimes aids in stabilizing the economic conditions.

## Cotton

Several attempts to grow cotton in Japan have been failures. It is said that it has recently succeeded in Korea. Raw cotton is imported from America, India and China.

The first spinning mill was built in 1860. The industry grew until in 1927 there were 257 mills with over 6,000,000 spinning spindles, and Japan was the sixth nation in this respect.

Not only do the Japanese consume a large amount of the product, but the value of the exports is second on the list.

In accordance with the new factory law, beginning July 1, 1929, the employment of minors and women is prohibited during the night hours. The workers are now divided into two shifts of eight and one-half hours each. Considerable attention is now being given to welfare work.

There is now overproduction and the necessity of curtailing. This sounds familiar to us. Unlike our industry, there is the Great Japan Spinning Union, established to further the industry. Something like this, if legal, would help us.

## Woolen and Worsted

Woolen spinning and weaving was started in 1897, when a military cloth mill was built by the government.

Sheep breeding has been attempted, but has not been a success. On this account, nearly all wools are imported in the grease, or in tops or yarn.

In 1926 there were about 73,000 woolen spindles and 350,000 worsted spindles.

### DYEING INDUSTRY

Dyeing is a very old art in Japan, and remarkable progress was made about 1700. After the beginning of the Meiji period, great attention was given to this subject. Technical schools were established. The first company was organized in Kyoto in 1888, with steady development up to the time of the World War, when there was an increase of over ten times. The industry is now in excellent condition.

FIG. 7. — GARDEN

### TEXTILE MACHINERY

I visited only two mills, one cotton and one silk. The machinery was as good as is found in the average of our mills, and the buildings almost as good.

I was told by an English inspector that the Japanese did not hesitate to spend money for anything which promised to be an improvement.

## CERAMIC INDUSTRY

The ceramic art came from Korea and China, but the Japanese, by study and development, have produced wares in harmony with their own taste. The utensils used for tea ceremonies expressed the spiritual beliefs of the people and exerted great influence on the design of the ceramic wares for other purposes.

After the Restoration, important technical progress has been made in the manufacture of industrial and artistic pottery, and as a result there is enough produced for domestic use and for the foreign market, and now it is one of the important items among the exports.

There is scarcely a province which does not produce pottery with its own characteristics, not only for domestic use, but also of artistic and decorative value.

Encouragement given to the industry by the government, importation of machines after investigation abroad, and the employment of foreign specialists have been instrumental in building up a factory system in place of much of the manual methods formerly used. However, as but little capital is required for starting on a small scale, there are a great number using the older methods.

The government maintains several ceramic experimental stations for industrial and artistic research. Each of the stations issues reports for the guidance of workers in these industries.

All sorts of styles and artistic technique are produced, resulting in an infinite variety of expression.

## GLASS INDUSTRY

In 1861 the government established a glass works with experts from England. As the people working in the factories acquired knowledge of the art, other factories were started, and by 1888 the industry was flourishing. It is now one of the foremost industries of the country.

The demand for plate glass is large, following the requirements in the construction of large buildings after the western style. The demand for bottles is for beer, cider and other drinks. The capacity of plants for the production of bottles seems to be about 1,000,000 a day.

## CEMENT INDUSTRY

About 1897, scientific methods were coming into use and research work was done in connection with the manufacture of Portland cement.

In 1907, after the Japanese-Russian War, the country began to develop rapidly, and with it the cement industry grew, and the product was improved.

During the World War many new plants were added, and existing plants increased production, and after the close of the War there was overproduction. The importation of cement had ceased in 1914, but again began after the earthquake of 1923, but did not last long.

## BREWING INDUSTRY

### *Sake*

Brewing is one of the most important industries. Sake, the national drink, is manufactured from rice. Its color is like that of white wine, and its taste is different from all other alcoholic beverages.

FIG. 8. — MODERN TOKYO

It is impossible to ascertain when it first became known to the Japanese. It was probably introduced by Koreans who obtained knowledge from the Chinese.

No scientific account of the brewing of sake appeared before 1878. Since then remarkable progress has been made, and now there is a yearly production of about 200,000,000 gallons. The government tax in 1927 amounted to more than $100,000,000, and is one of the most important items of revenue.

The average yearly consumption per capita is not quite three gallons.

### *Beer*

Beer was first imported in 1871. In 1876 a brewery was established by the government, and since 1890 remarkable progress has been made. The amount has gradually increased until in 1927 the production was about 32,000,000 gallons, a considerable amount of which is exported. The quality is good.

Although there are no restrictions on the sale and consumption of alcoholic drink, I did not see any sign of its abuse.

### Pig Iron and Steel

In the olden days, iron and steel manufacture was limited to the production of armor and swords. It was not until 1874 that western methods were adopted, when the government equipped the Kamaishi mine with the latest machinery from abroad. The experiment was a failure, and no further attempt was made to manufacture steel until 1897, when the government erected a mill at Edamitsu. This second experiment was not successful until the World War, when prices rose, and many iron and steel foundries appeared. With the close of the war there came a great depression, and, one after another, these mills closed down. Those which survived continued production. Their persistent efforts to place the industry on a paying basis have begun to bear fruit, and it is stated that the country is about to become self-supporting in iron and steel. The demand for steel in Japan is increasing. If the government and private organizations co-operate to produce pig iron and steel in mass production and avoid competition, the industry will be put on a firmer basis and be able to combat invasion of foreign products.

### Shipping and Shipbuilding

There was not any great progress in shipbuilding in Japan until the requirements of war compelled it. When the Sino-Japanese War broke out, there were only about 182,000 tons of vessels. All the larger vessels were requisitioned by the government, causing a great shortage. As a consequence, the shipbuilding industry was increased. The first steel vessel of over 1,000 tons was built in 1895.

The war with Russia gave another impetus to shipbuilding. At the end of the war Japan had about 1,034,000 tons gross.

In 1909 the Ocean Navigation Subsidy Law was passed and the Shipbuilding Bounty Law amended. These two laws encouraged the industry, and many big steamers were built.

The World War affected the industry tremendously. At the beginning, as foreign trade fell off, regular service stopped, and banks suspended business. In due time they recovered, and exports of war materials and foreign goods developed a boom. The amount of foreign trade was about quadrupled, and the shipping made great developments. Shipyards were enlarged and new ones started.

In 1929 there were registered 3,321 vessels of 3,753,765 gross tons, or about two and one-half times as much as before the war. There was a pronounced depression after the war, and shipbuilding declined rapidly.

In spite of the depression, the technical progress of shipbuilding was furthered in the meantime. Battleships, cruisers, auxiliary warships and merchant steamers are now built in private yards with satisfactory results.

Fig. 9. — Prefecture Building, Yokohama

Five experimental naval tanks have been installed, one recently, which are of great assistance in the designing of ships.

None of the factors tending to increase tonnage are in existence now except the subsidy. There is much concern as to how to keep the skilled mechanics so that they will always be available when required.

With the scarcity of raw materials and national resources, it follows that safety and security are dependent upon Japan's marine transportation and navy.

## Railways

The Japanese government has long followed the policy of nationalizing lines in Japan proper, and, in pursuance of it, the state at present owns and operates practically all the important lines. No efforts have been spared in bringing about improvements in every sphere of operation.

The gauge is 3′ 6″, and was probably adopted because the foreign engineers, engaged originally, thought it best fitted for the country, and because of the less cost than if built on European standards. This has been found to be insufficient to meet with the growing demand of traffic, but has not been changed, and every effort has been made to improve the rolling stock.

Japan is handicapped topographically for railroad construction. Even the task of location is quite difficult, with many heavy gradients, tunnels and bridges. The engineering and construction work appeared to be excellent.

The trains are run exactly on schedule, and are very smooth riding and comfortable. The system seems to be working perfectly.

The Government Railways maintains six institutions for training students in railway business, and scholarships are provided for sending those selected to universities or colleges for higher instruction.

The Department of Railways exercises control over the state lines and superintends private companies.

In the early days, the materials, including rolling stock, and management were imported from England. At present, all machines and materials are made in Japan.

## Electrification

They are quite keen on electrification. A good many miles are now electrified, and more is contemplated.

## Electric Power

Because of the heavy rainfall in Japan and the steep slopes of many of the rivers, there are many opportunities for hydro-electric developments. In the, so-called, Japanese Alps the rainfall is heavy, and high heads are available, so that about one-half the power developed is in these mountains, which are within easy transmitting distance of Tokyo and Osaka.

According to government investigations, there is about 7,000,000 theoretical horsepower available throughout the year, and about 13,000,000 for six months. At the end of 1926 the developments had reached about 2,000,000 kilowatts, and many more are under construction or planned.

Most of the high heads have now been utilized, and studies are now being made for low head development with large flows.

Especial study is given to the design and construction of dams to resist earthquakes.

Reservoirs are being built to stabilize the flow, and steam plants to make up the deficiency. The steam stations which have been built recently are based on American and European practice, with special study of adaptation to the conditions in Japan.

The total energy consumed in 1926 was about 9,350,000,000 kilowatt hours, of which 86 per cent was supplied from hydro-electric stations.

## Electric Transmission Systems

The real first important hydro-electric development with modern transmission lines was not finished until 1914, and since then progress has been great.

Fig. 10. — Mt. Fugi

These undertakings are operated largely by private capital, under the supervision of the Ministry of Communications, which established a scheme for principal transmission systems. Under this guidance the principal network has been carried out.

There are two frequencies, — that of the Tokyo Electric Light Company, at 50 cycles, and the Osaka and Nagoya, at 60 cycles. Attempts have been made to standardize the frequencies, but the expense has been too great. To overcome this difficulty, stations are built to provide current with both frequencies.

## Manufacture of Electrical Machines and Materials

The manufacture of electrical machinery, cables and materials was started in a small way. After 1886 it gained impetus and gradually increased, but most of the machinery was imported from Europe or America.

When the World War broke out, practically evey line of industry became prosperous, and with the great difficulty of getting anything from other countries there came about great developments to supply the home demand.

After the war there was a tendency for the Japanese to work in conjunction with first-class manufacturing concerns in Europe and America, which has brought about a marked improvement in design and construction.

There was a dropping off in production after the war, but in 1925 the value of the total production was up to that of 1921, and now the production is sufficient to fill the home demand.

## Mining and Metallurgy

No records are found of the mining industry earlier than 600 to 700 A.D. Metals were required for coinage and for construction of Buddhist images and temples, and were imported from China and Korea. The government adopted a policy of encouragement about 700 A.D.

In the eleventh century mining was developed on a larger scale, increasing as time went on. It was only after 1700 that coal and oil were produced. In the nineteenth century, modern American and European methods were adopted with increased production.

The notable increases in production between 1913 and 1926 are in pig iron, nearly four times, and steel, nearly six times. The only thing produced in sufficient quantity to supply the home demand is coal.

## Other Industries

There are many other and smaller industries which, while important and necessary, do not affect the economic condition greatly, one of the most interesting ones being the production of pearls, but this paper would be too long if a description of them were included.

## CONCLUSION

The most astonishing thing to me is the fact that practically everything of modern improvement begins with the year 1868, and that such rapid advancement has been made in the relatively short period of about sixty years.

The indications are that the Japanese are aiming at an industrial conquest of their portion of the world.

With all the wonderful progress, it would be regrettable if the desire to be modern should predominate to such an extent as to crowd out the traditions and customs of ancient times, which are of great value to any country.

# OF GENERAL INTEREST

## THE CHARLESTOWN WATER WORKS (MYSTIC SYSTEM), 1865

*By Charles W. Sherman* *

In 1865 the Commissioners charged with constructing a water works system for the (then) city of Charlestown presented their final report, including that of their chief engineer, C. L. Stevenson, containing a complete description of the works. This report is a very readable document, and shows why the source was selected and what was expected of it.

The drainage area of upper Mystic Lake is given as 31 square miles, and its storage capacity as 380,000,000 gallons. Its safe yield was estimated at 30,000,000 gallons daily. The contrast between this figure and the actual safe yield of 7,000,000 gallons per day found in later years is notable, although it must be remembered that diversion of water from the lake by sewers resulted in a considerable reduction of the available quantity of water.

"The water of Mystic Lake is celebrated for its purity," says the report, which also quotes opinions of Professors Horsford and Silliman, among the foremost chemists of that time. Evidently the tanneries of Woburn and Winchester had not then begun to pour their wastes into the Aberjona River

The cost of the works was about $730,000, having been increased considerably by the necessity of carrying on much of the construction during the Civil War period. The works included a dam 1,560 feet long across the narrows between upper and lower Mystic Lakes, raising the water of the upper lake 7 feet; a brick aqueduct 5 feet wide by 5 feet 8 inches high from the lake to the Mystic River, near the pumping station, a distance of 7,453 feet; two 48-inch cast iron pipes 487 feet long under the river and leading to the pumping station; a brick pumping station near the mouth of Alewife Brook, containing two Worthington "Duplex Pumping Engines" of 5,000,000 gallons' daily capacity each, which showed the almost unprecedented duty of 850,000 foot-pounds per 100 pounds of coal; a 30-inch cast iron force main from the pumps to the reservoir near Tufts College, 3,277 feet; the reservoir of 26,000,000 gallons' capacity; a 24-inch cast iron supply main from the reservoir to Charlestown Neck (Sullivan Square), 16,557 feet long; and a distribution system consisting entirely of wrought iron cement-lined pipes from 4 to 16 inches in diameter, totalling 18 miles in length.

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* Of Metcalf & Eddy, Engineers, Boston, Mass.

Much thought was given to the selection of the kind of pipe for the distribution system, and careful study was made of the experience of Boston and other cities with the deterioration of cast iron pipes from tuberculation. The advantages supposed to favor this type of pipe were listed by the engineer as follows:

> First, it will stand any desired pressure.
> Second, it can be laid in our streets with safety.
> Third, it costs less when first laid.
> Fourth, it costs less for repairs.
> Fifth, oxidation does not occur.
> Sixth, it insures greater purity to the water.
> Seventh, there is no loss of discharge from diminished bore.
> Eighth, less size of pipe can be laid.
> Ninth, it increases rather than diminishes in strength with age.
> Tenth, it can be more readily tapped for services.

Mr. Stevenson stated that this kind of pipe had been in use for eighteen years prior to that time, and that some 150 miles of it had been laid. "At the time when the works were being designed, although many miles of this pipe had been laid in other places, yet in none had it been adopted as a system for a whole system or town." Mr. Stevenson's expectations as to the permanency of this pipe have been proven almost as wide of the facts as the estimated safe yield.

This description of a water works system built more than sixty-five years ago provides interesting reading to the water works engineer of the present day, particularly in showing the matters in which the expectations of the engineer have not been realized. If similar descriptions of works were more often prepared after the completion of construction, engineering literature would be more interesting, and it would be easier to trace the development of experience and to learn why certain practices once current have been practically abandoned.

# PROCEEDINGS OF THE SOCIETY

## MINUTES OF MEETINGS

### Boston Society of Civil Engineers

May 21, 1930. — A regular meeting of the Boston Society of Civil Engineers was held this evening in the Lounge, Boston Chamber of Commerce Building, and was called to order at 7.15 by the President, Lewis E. Moore. There were about one hundred members present.

The President announced that the minutes of the previous meeting (April 16, 1930) would appear in the May Journal.

The Secretary reported the names of those elected to membership by the Board of Government on May 21, 1930, as follows:

*Grade of Member:* John B. Drisko, Samuel M. Ellsworth,* Arnold H. Engbord, Edward K. Hull. *Grade of Junior:* Theodore M. Vader.

The President reported that the Board of Government had voted to omit the regular June meeting in order to unite with the New England Water Works Association in an outing to be held on June 25, 1930, at the Pilgrim Hotel, Plymouth.

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* Transferred from grade of Junior.

The President announced the death of the following members of the Society:

Clayton C. Alexander, died April 1, 1930, a member since November 17, 1915.
William L. Vennard, died April 29, 1930, a member since October 15, 1913.
John V. Corbett, died May 14, 1930, a member since January 24, 1923.

Committees will be appointed to prepare memoirs.

The Secretary presented a proposed amendment to the seventh paragraph of Section 5 of the By-Laws, which the Board of Government on April 14, 1930, had voted to recommend to the Society for adoption, and notice of which had been printed in the announcement of this meeting. It was *Voted* that the seventh paragraph of Section 5 of the By-Laws be amended to read as follows:

> Whenever a President, Vice-President, Director, Secretary or Treasurer is to be elected, the Nominating Committee shall nominate one candidate for each office to be filled. Whenever a member of the Nominating Committee is to be elected the Nominating Committee shall nominate two candidates for each office to be filled. Ballots shall provide space for the writing or pasting in of additional names by the voters.

In accordance with the By-Laws, this proposed amendment will be presented for final action at the September meeting of the Society.

The President then introduced the speaker of the evening, Mr. Charles T. Main, Past President of the Society, who gave an address on "Engineering and the Industries of Japan."

A general description of the characteristics of the people and their life, a review of the rapid development of their activities through the adoption of western ideas in engineering and industries, together with an account of the World Engineering Congress held in Japan in October and November, 1929, made a very interesting paper.

Mr. D. O. Blake, Vice-President of Frazer Trust Company, Tokyo, Japan, a guest attending the meeting, commented briefly on the Japanese people with whom he had been living for nearly forty years.

Meeting adjourned at 9.30 P.M.

EVERETT N. HUTCHINS, *Secretary.*

## Designers Section

MAY 14, 1930. — A regular meeting of the Designers Section was called to order at 6.10 P.M. by LeRoy M. Hersum, Vice-Chairman, in the rooms of the Engineering Societies.

The minutes of the April meeting were read and approved.

Prof. Hale Sutherland of the Massachusetts Institute of Technology was introduced as the speaker of the evening. Professor Sutherland discussed, with blackboard illustrations, the "Analysis of Continuous Beams and Rigid Frames by Cross' Method of Moment Distribution," a method of analysis which may often be used to advantage instead of the three moment equation on account of its simplicity of application.

At the conclusion of the talk there was general discussion of the subject.

There were forty-five members and guests present.

The meeting adjourned at 7.20 P.M.

LAWRENCE G. ROPES, *Clerk.*

## Highway Section

MAY 28, 1930. — A meeting of the Highway Section was held in the rooms of the Engineering Societies, Tremont Temple, and was called to order by the Chairman, Mr. James E. Lawrence, at 7.10 P.M. The minutes of the meeting held February 26, 1930, were read and accepted.

The Chairman then introduced the speaker of the evening, Col. H. L. Bowlby, General Manager of Flintkote Roads, Inc., New York. Colonel Bowlby gave a very interesting talk on "Bituminous Emulsions and Cold Asphalt Road Emulsions." He particularly stressed the fact that the use of cold asphalt emulsions resulted in a denser and less slippery roadway pavement, and pointed out that cold asphalt emulsions could be applied to cold and wet broken stone. A discussion followed in which Messrs. Ambrose, Coburn, Edwards, Knowlton, Lawrence, Mathers, McAvoy, Rice and Rogers took part.

There were forty members and guests present.

The meeting adjourned at 8.30 P.M. after according Colonel Bowlby a rising vote of thanks.

ERNEST MATHERS, *Clerk.*

## Northeastern University Section

On Friday evening, May 16, 1930, the Northeastern University Section, of the Boston Society of Civil Engineers, held its last meeting of the year in Room 26H, Huntington Building. The meeting was called to order by Vice-Chairman John W. Greenleaf, Jr., and the reports of the Secretary were read and approved. The remainder of the business meeting was devoted to the election of officers for the ensuing year. The following officers were elected:

Chairman — John H. Lowe.
Vice-Chairman — George L. Gorbell.
Clerk — Carl A. Magnuson.
Executive Committee — Raymond E. Edson, John W. Lymberg, Merton E. Sylvester.

At the close of the business meeting Vice-Chairman Greenleaf introduced as the speaker, Col. Lewis E. Moore, President of the Boston Society of Civil Engineers. Colonel Moore graduated from the University of Wisconsin and Massachusetts Institute of Technology, and during his engineering career has served as professor of structures at M. I. T., engineer in charge of the design of the Cottage Farm bridge, and as redesigner of the Harvard bridge.

Colonel Moore presented a rather unusual talk on "The Engineer," and cited interesting incidents of his own experience in the engineering profession. He endeavored to describe the various fields open to college graduates in engineering and their relative advantages and disadvantages. At the conclusion of his talk a question period was in order.

After all present had expressed their thanks to Colonel Moore for his interesting talk, refreshments were served, and the meeting adjourned at 9.45 P.M. There were 23 members present.

ERNEST S. HILL, *Clerk.*

## APPLICATIONS FOR MEMBERSHIP

[June 20, 1930]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

*For Admission.*

PRESUTTI, ACHILLE L., Everett, Mass. (Age 28, b. Italy.) Graduate of Boston English High School and had two years at Northeastern Polytechnic. Experience: one year with G. H. Gottschalk of Chicago; one year with Barber Company, contractors, of Boston; one year with Walworth-English-Flett Company; three and a half years with Jackson & Moreland. Work has been drafting, estimating and pricing for heating and ventilating contractors; is a draftsman now with Jackson & Moreland. Refers to *E. H. Cameron, F. M. Carhart, W. D. Henderson, H. B. Perry.*

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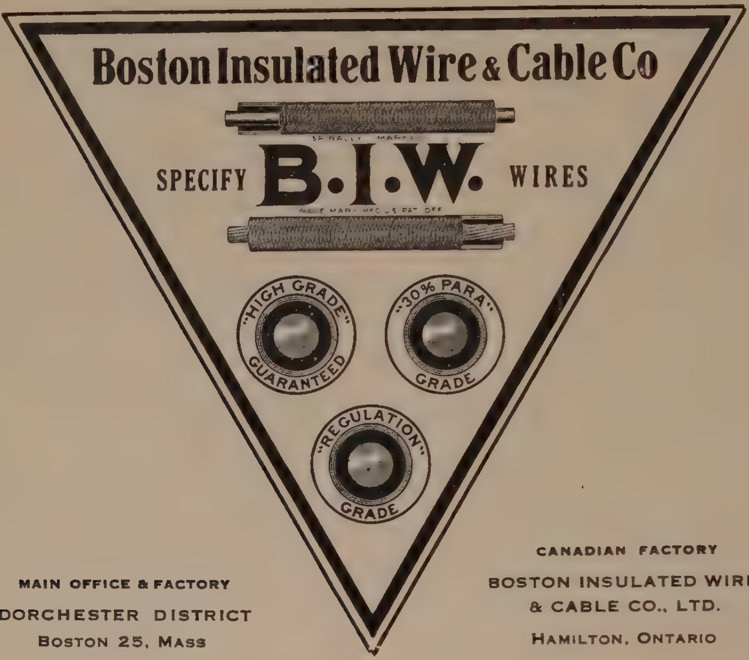

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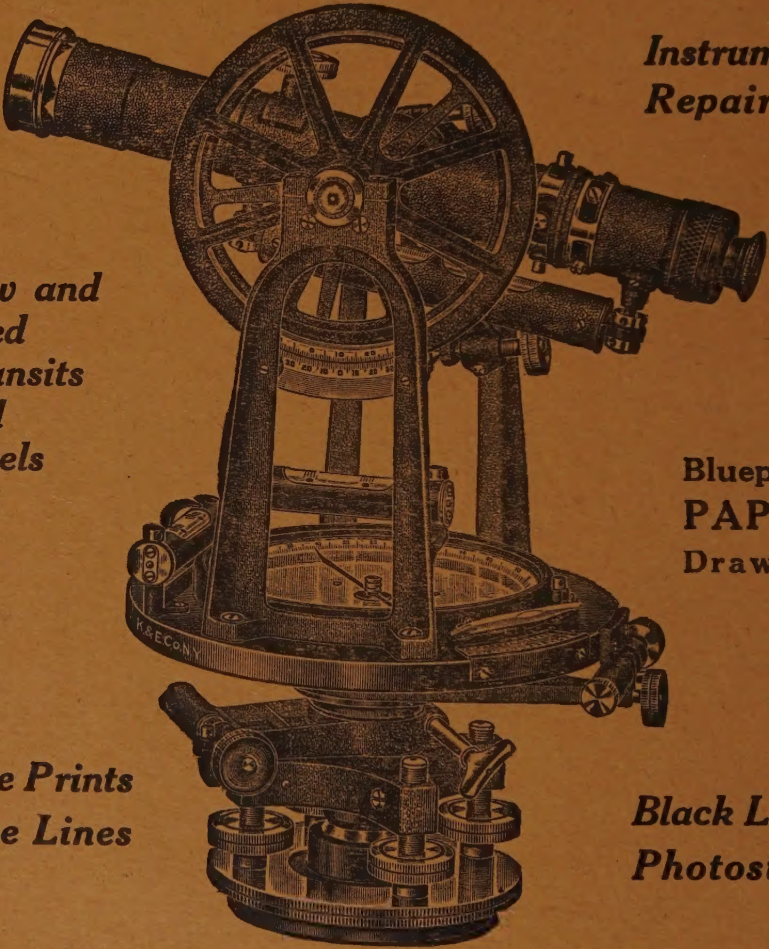

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